PROJECT PROGRESS REPORT

PREPARED FOR THE ALASKA ENERGY AUTHORITY BY
THE ALASKA CENTER FOR ENERGY AND POWER

PROJECT TITLE: *Round 1:* Emerging Energy Technology Fund – Data Collection

REPORTING PERIOD: 3rd Quarter 2016

DATE OF REPORT: October 14, 2016

GRANT RECIPIENT:
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EETF Round 1 Projects

Project #003 – Alaska Division of Forestry, Biomass Reforestation

This project is complete, and a final report from the Division of Forestry is forthcoming.

Project #006 – Arctic Sun, Arctic Thermal Shutters and Doors

This project has reached completion. ACEP has completed its final report and awaits final comments from AEA.

Project #009 – Genesis – Ultra-Efficient Generators and Diesel-Electric Propulsion

This project was concluded at its current stage of development. ACEP will communicate with AEA about appropriate final reporting activities.

Project #026 – Cold Climate Housing Research Center (CCHRC), Ground Source Heat Pump (GSHP)

The ground source heat pump located at the Cold Climate Housing Research Center continues to operate normally. Over the last year, the system has operated with an average coefficient of performance (COP) of 3.1. The COP values over time are plotted in Figure 1, showing a decline between October 2015 and April of 2016. This trend is expected as the heat pump removes heat from the ground. During the short burst of data collected for October 2016 (the heat pump was turned off during the summer when there was no heating load), the COP values returned to their high early season values. In fact, it appears that they are higher in October 2016 than they were in October 2015, as shown in the graph below.

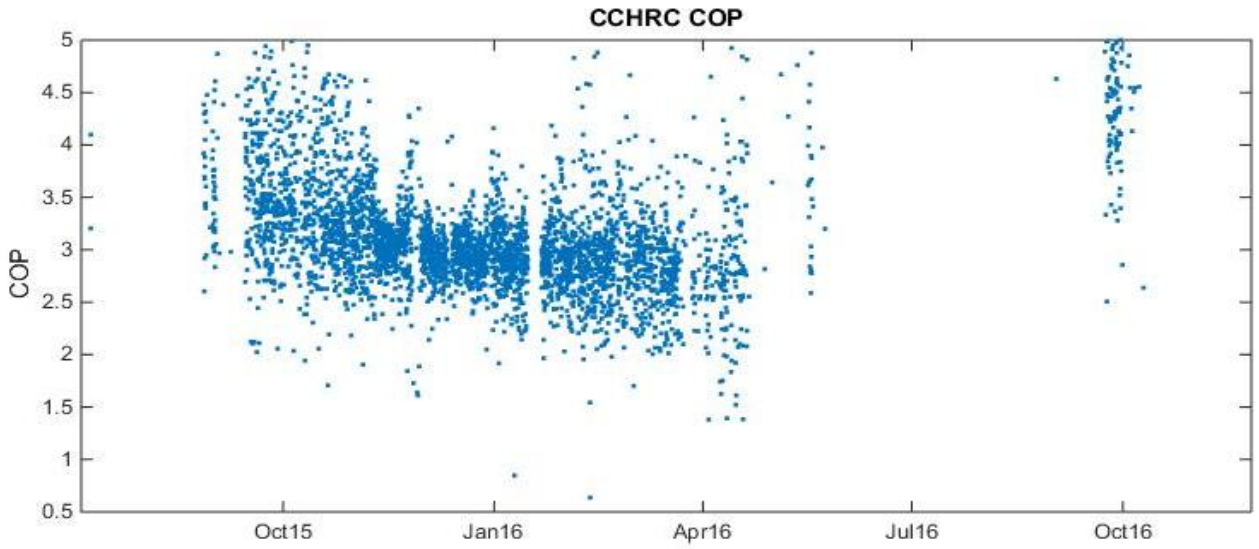

Figure 1: CCHRC GSHP COP values between October 2015 and October 2016

Figure 2 shows temperatures recorded at the approximate depth of the buried heat pump ground loops. The lines labeled as "string" show temperatures collected outside of the heat pump ground loops, while the lines labeled as "loop" show the temperatures collected at the heat pump ground loops. All the data is collected from the same depth and show that overall soil temperatures are higher in October 2016 than in October 2015, which also explains the higher October 2016 COP values.

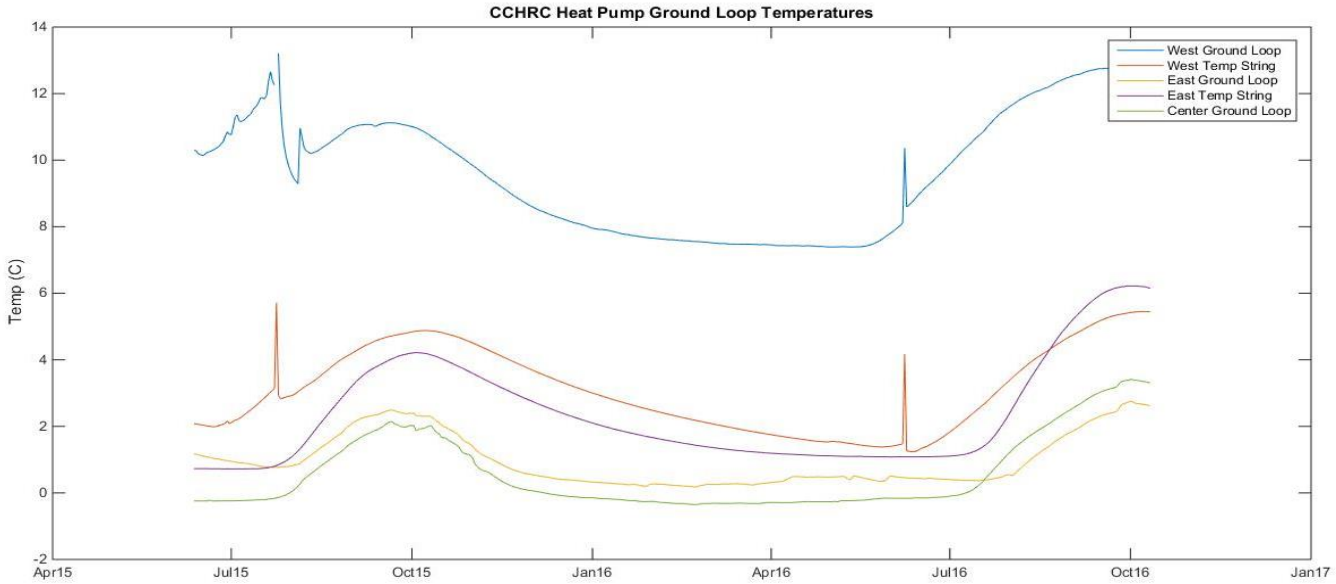

Figure 2: CCHRC GSHP recorded temperatures. The lines labeled as "string" show temperatures collected outside of the heat pump ground loops, while the lines labeled as "loop" show the temperatures collected at the heat pump ground loops.

Project #028 – University of Alaska Fairbanks (UAF), Organic Rankine Cycle (ORC)

In reviewing the UAF ORC final report to AEA, all data collection tasks appear to have been completed with the exception of data transmission to ACEP. Without this data, ACEP is hesitant to verify analysis and conclusions. In addition, clarification is needed on condensation drop size measurement techniques (photos would be extremely useful) and measurement uncertainties for better comparison of data trends. The report would also benefit from detailed technical editing.

While the heterogeneous surface does show improved performance over a traditional non-treated surface, the cost effectiveness of the heterogeneous surface has not been addressed for commercialization of this technology. ACEP may be able to add value on this topic in its final report.

Project #029 – University of Alaska Fairbanks, Exhaust Thimble

This project has reached completion. ACEP has completed its final report and awaits final comments from AEA.

Project #035 – Altaeros, Airborne Wind Turbine

According to its final report submitted to AEA, the Altaeros project team completed site selection, turbine design and testing, and initial safety and shakedown testing of the flight platform without the turbine. It should be noted that full load testing was not completed for the turbine, and the full-scale generator and power conditioning system were not built or tested. No data were transmitted to ACEP for analysis. ACEP will discuss with AEA next steps and final reporting obligations.

Project #037- Oceana, Hydrokinetics; Project #043 – Ocean Renewable Power Corporation (ORPC), Hydrokinetics; Project #058 – Boschma Research Inc. (BRI), Hydrokinetics

ACEP has written a draft final report that discusses the three hydrokinetics projects from EETF Round 1 funding. The report also presents the analysis that ACEP has done on the data collected during the projects. The draft final report has been reviewed by ACEP staff as well as by Oceana staff and ORPC staff. The report was submitted to BRI, but no response has been received from them. The comments received from Oceana and ORPC are being incorporated into the report. In addition, ACEP held a teleconference with ORPC staff engineers at the beginning of October to discuss findings and the report status.

In general, ORPC expressed that they were impressed with the report and recognized the difficulty of discussing three different hydrokinetics projects in one report. Their specific suggestions included:

- A discussion of the difference in algorithms that ACEP used versus the algorithm that University of Washington used to process ORPC data and calculate the power curve.
- A discussion of data quality for the three projects so readers have a better idea about project and data comparisons.
- A discussion of the challenges of standardizing data collection and developing a power curve in a river environment when the water velocity has small variations. Monty Worthington is involved in these standardization efforts, and he has submitted a paragraph to ACEP that will be incorporated in the report.
- A discussion of velocity sheer and its effect on the turbine.

Project #045 – Hatch, Flywheel

This project has reached completion. ACEP has completed its final report and awaits final comments from AEA.

Project #049 – Intelligent Energy Systems (IES), Self-Regulated Grid; Project #051 – Intelligent Energy Systems (IES), Wind-Diesel-Battery Hybrid System

No new data has been transmitted to ACEP. ACEP is working towards a final report.

Project #061 – Marsh Creek, Various Speed Diesel-Electric Generation

ACEP awaits final materials from Marsh Creek.

Additional Project – Northwest Arctic Borough, Arctic Field Testing and Power Curve Verification of Eocycle 25 kW Wind Turbine

ACEP continues to receive monthly data sets for the Eocycle 25 kW wind turbine in Kotzebue. The turbine appears to be functioning as expected with generation amounts in line with manufacturer specifications. The data collected up until this point is for the summer months when wind speed is typically lower than in the winter. The hourly wind speed data is shown in Figure 3.

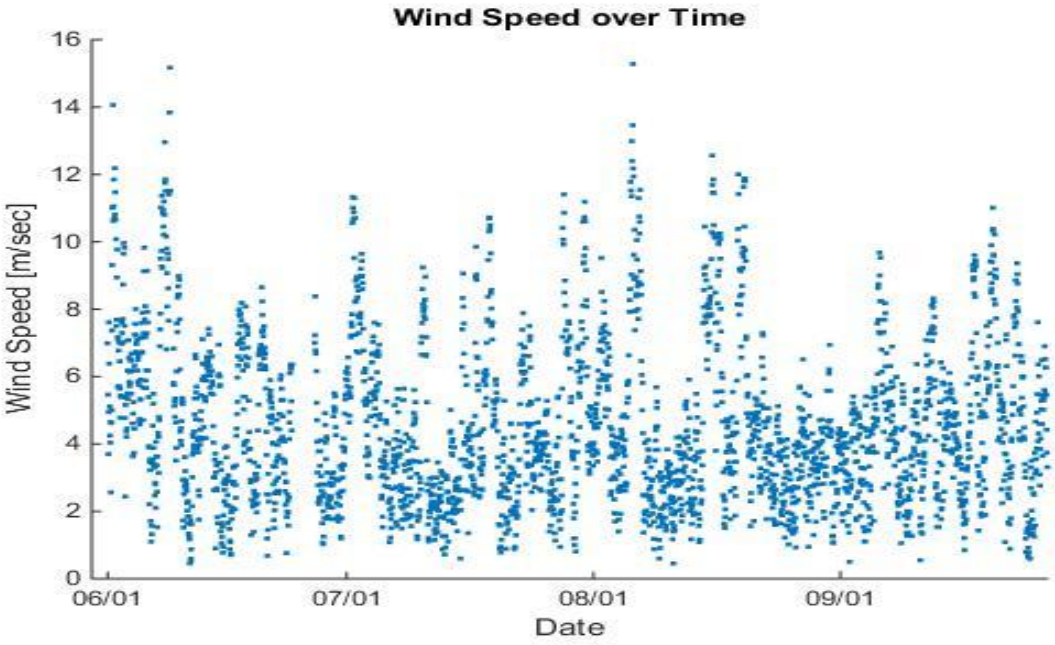

Figure 3: Hourly wind speed data between June and October 2016 for the Eocycle 25kW wind turbine in Kotzebue.

Figure 4 shows the daily energy production from the turbine. The maximum daily energy production to date was 400 kWh which occurred in the beginning of July. The daily capacity factor on this day was approximately 66%.

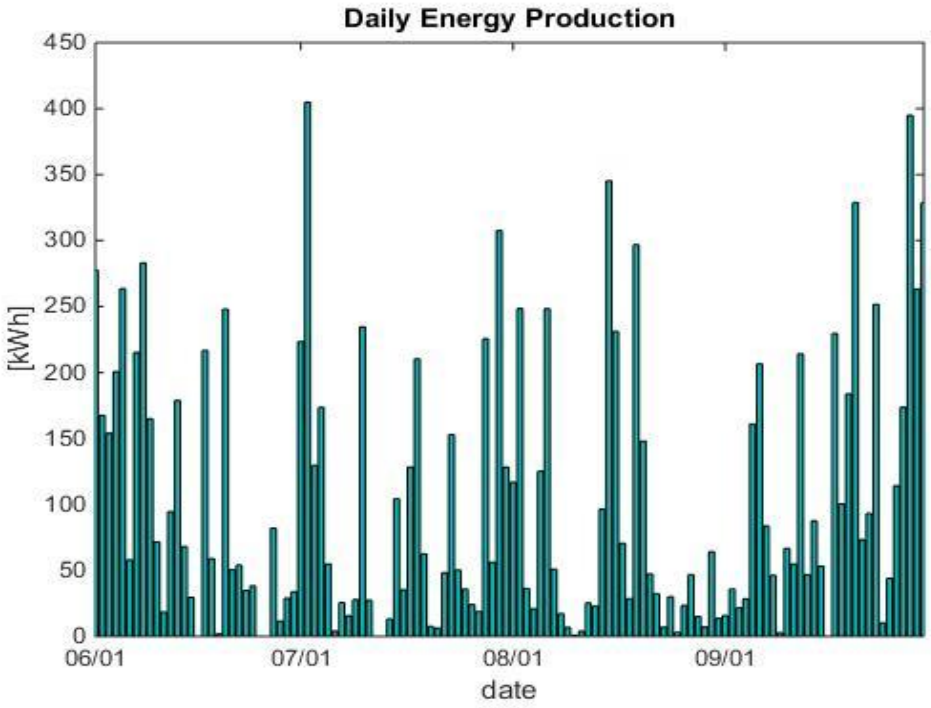

Figure 4: Daily energy production between June and October 2016 for the Eocycle 25kW wind turbine in Kotzebue.

The primary stated purpose of the Eocycle testing is verification of the manufacture's power curve and testing the turbine robustness in the Arctic environment. The data collected to date have resulted in the power curve shown in Figure 5. It should be noted that testing has only occurred in the summer months when the wind speed is typically lower. As we progress into the winter testing season, the data collected should begin to fill in the right side of the power curve, and the power curve can then be more accurately compared to the published power curve generated by the manufacturer.

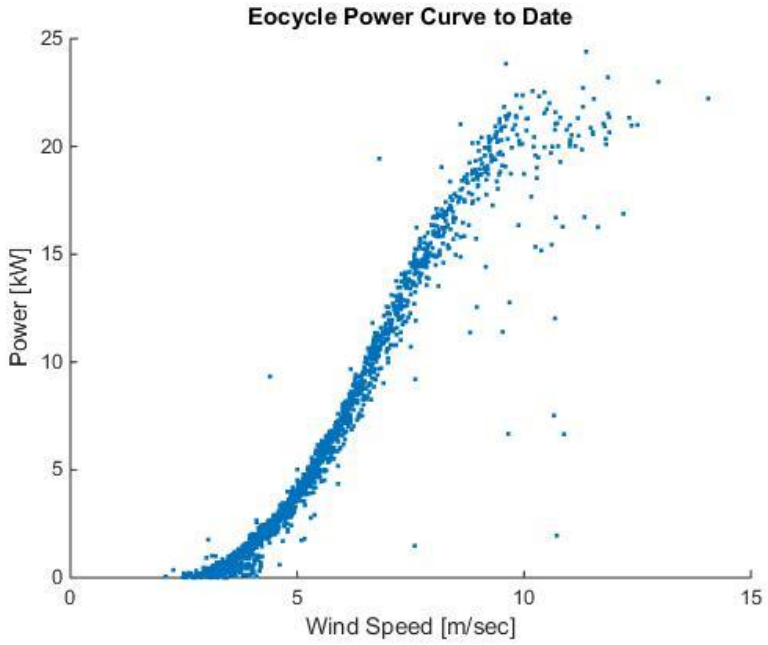

Figure 5: Power curve for Eocycle 25kW wind turbine from data to date.

To date, the Eocycle turbine has seen a maximum efficiency near 50% at a tip speed ratio of ~8 (see Figure 6). While the maximum efficiency and tip speed ratio are important from a data collection point of view, they are relatively academic in nature. The true test of the turbine is whether it produces as much energy as expected and if maintenance costs can be minimized.

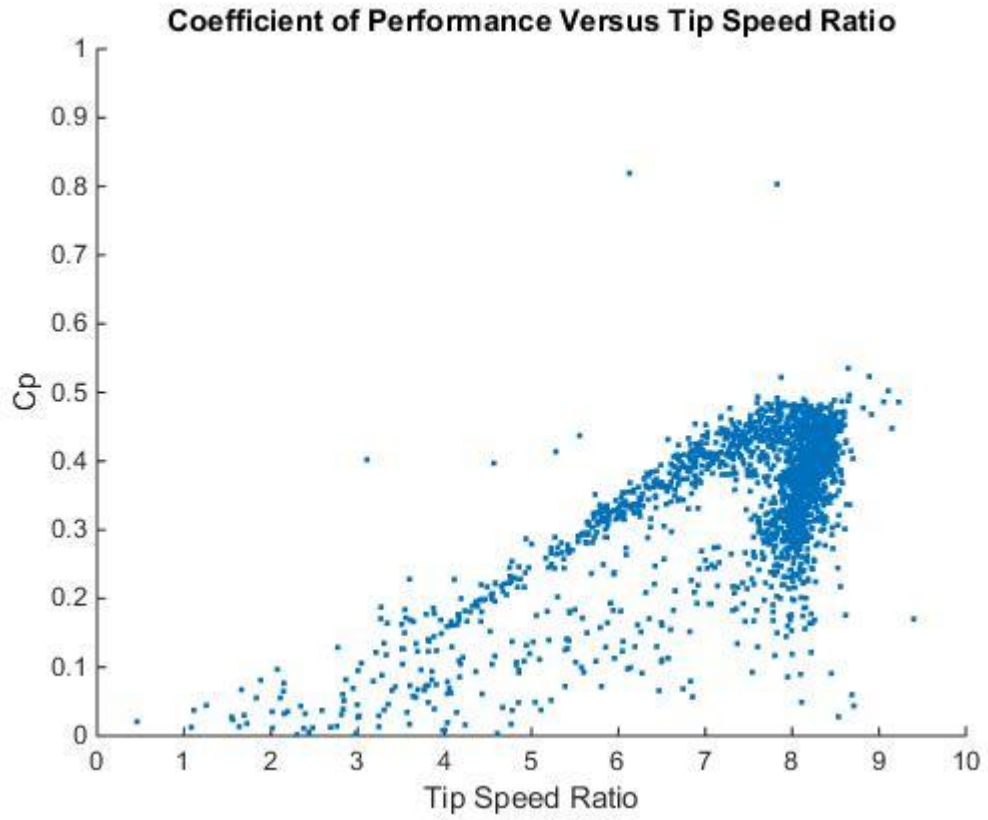

Figure 6: Eocycle wind turbine coefficient of performance vs. tip speed ratio from data collected to date.